Replacement Research Reactor Project

MANAGEMENT OF RADIOACTIVE WASTE

Prepared By
Australian Nuclear Science and Technology Organisation

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 PURPOSE

This document describes the organisational arrangements and responsibilities for the control, storage and transfer of the radioactive waste generated from the Reactor Facility. It details how solid and liquid radioactive waste generated by the operation of the Reactor Facility is transferred to ANSTO's Waste Operations and Technology Development (WOTD) section. The systems and processes outlined in this document address current best practice, including waste minimisation principles, and are in line with IAEA guidelines for the safe management of radioactive waste.

1.2 SCOPE

This document addresses the following:

1. The management, including storage and minimisation, of radioactive waste arising from operation of the Reactor Facility.
2. System descriptions of the waste handling facilities within the Reactor Facility.
3. Compliance with current best practice (in line with IAEA guidelines) relating to the standards and regulations for radioactive waste management and its ultimate disposal. The plan is linked to other established ANSTO operational plans and arrangements that combine to provide for the safe monitoring, control and management of all generated airborne, liquid and solid radioactive wastes.
4. The radioactive waste management system interfaces with the existing, licensed, WOTD facilities. Details of the existing arrangements within WOTD were given at the time of ANSTO's site licence application and are not repeated here.

2 REFERENCES

1. Regulatory Guideline on Review of Plans and Arrangements, ARPANSA, RB-STD-15-03, Version 0, August 2003
2. ANSTO/Sydney Water Trade Waste Agreement, 2003.
3. ANSTO Safety Directive 5.7: Safe Management of Radioactive Wastes.
4. ANSTO's Safety Directive 5.6: Safe Movement and Transport of Radioactive Materials
5. APOL 2.2 Radioactive Waste Management Policy
6. APOL 2.1 Health, Safety and Environment Policy
7. APOL 2.2 D 01 Delegations for Waste Management
8. WOTD Quality System Procedures – ISO 9000:2001 certified.
9. WOTD Exempt Level Waste System – NWP 9.8.5 Disposal of Exempt Level Waste from LHSTC
10. RRRP-7082-ECEJH-001 Environmental Management Plan
11. RRRP-7280-EDEIN-004 Preliminary Waste Management Analysis, Waste Estimation and Treatment
12. IAEA Technical Report No. 383, Characterisation of Radioactive Waste Forms and Packages

13. IAEA (1996) – Regulations for the Safe Transport of Radioactive Material – No. TS-R-1 (ST-1, Revised)
14. IAEA – TECDOC-855 Clearance Levels for Radionuclides in Solid Materials
15. IAEA International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources, Safety Series 115 (IAEA Vienna 1996)
16. IAEA Radioactive Waste Safety Standard (RADWASS) Publications
17. IAEA Draft Safety Requirement NS-152, Pre-disposal Radioactive Waste Management, including Decommissioning (October 1998)
18. IAEA Safety Series No. 111-F, The Principles of Radioactive Waste Management (1995)
19. IAEA Safety Series No. 111-G-1.1 Classification of Radioactive Waste (1994)
20. IAEA Technical Report No. 377, Minimisation of Radioactive Waste from Nuclear Power Plants and the Back End of the Nuclear Cycle, 1995
21. Implementation of ANSTO's Radioactive Waste Management Policy, Action Plan 1996-2000
22. RRRP-7272-EDEIN-001 RRRP Operational Waste Management Plan

3 DEFINITIONS

The following definitions have been used in this plan.

The Reactor Facility; or the Replacement Research Reactor	The Reactor Facility means the multipurpose research reactor that will replace HIFAR and its associated buildings, physical plant, structures, components and systems including software and, where relevant, any management systems necessary to achieve the design, construction and operation of the facility.
The Project	The Project means all activities necessary to obtain the requisite approvals and procurement to achieve routine operation of the replacement reactor facility before 2006.
The site of the Reactor Facility	An area of approximately four hectares situated at the western end of the Lucas Heights Science and Technology Centre.,
The Lucas Heights Science and Technology Centre	An area of approximately 70 hectares, including a number of facilities immediately outside the perimeter security fence, such as the Lucas Heights Motel, canteen, Woods Centre, and other buildings in the ANSTO Technology Park.
The buffer zone	A mostly circular area of radius 1.6 kilometres, centred on the existing HIFAR facility, within which land use restrictions apply and all residential development is excluded.

3.1 ACRONYMS

ALARA	As Low As Reasonably Achievable, social and economic factors being taken into account
ALMO	Active Liquids Monitoring
ANSTO	Australian Nuclear Science and Technology Organisation
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
B Line	The identification given to low-level radioactive liquid waste lines that run from the pit tanks, delay tanks and/or buildings (including the Reactor Facility) to the Liquid Waste Treatment Plant at WOTD. There are stringent limitations on the radioactivity in this line (as per Safety Directive 5.7)

C Line	The identification given to normally non-radioactive liquid waste lines that run from the pit tanks, delay tanks and/or buildings (including the Reactor Facility) to the waste treatment facilities at WOTD. There are stringent limitations on the radioactivity in this line (as per Safety Directive 5.7)
CNS	Cold Neutron Source
EMS	Environmental Management System
Exempt Waste	A waste with activity below the limits set out in Schedule 2 of the ARPANS Regulations 1999.
HEPA	High Efficiency Particulate Air
HIFAR	High Flux Australian Reactor
IAEA	International Atomic Energy Agency
LEM	Liquid Effluent Monitoring
LHSTC	Lucas Heights Science and Technology Centre
LOCA	Loss of Coolant Accident
QMS	Quality Management System
RCPS	Reflector Cooling and Purification System
RLWM	Radioactive Liquid Waste Management
RLWMS	Radioactive Liquid Waste Management System
WASMO	Waste Streams Monitoring
WOTD	Waste Operations and Technology Development

4 ROLES AND RESPONSIBILITIES

The roles and responsibilities associated with the implementation of the waste management arrangements are as follows:

4.1 MANAGER, REACTOR OPERATIONS

The Manager, Reactor Operations, is the Nominee for the Reactor Facility and has overall responsibility for the safety and operation of the Facility at all times, including the management of radioactive waste, in accordance with procedures and operational manuals.

5 MANAGEMENT OF RADIOACTIVE WASTE

5.1 GENERAL

This Radioactive Waste Management Plan has been developed to interface and complement the Radiation Protection Plan, the Environmental Management Plan and the Effective Control Plan. This plan interfaces with the existing ANSTO plans and arrangements. The plans and arrangements include the existing licensed Waste Operations and Technology Development (FO0044-4B) facilities and provide ANSTO with current best practice in transport, treatment, conditioning, packaging and storage of the radioactive wastes.

Radioactive waste arising from the commissioning and subsequent operations of the Reactor Facility is managed in accordance with WOTD systems which are in line with current best practice including:

a) IAEA guidelines on waste handling,

b) IAEA Safety Standards and Guidelines

c) IAEA Codes of Practice

d) Requirements from federal and state authorities, and

e) Waste minimisation principles

The Quality Management System (QMS) for the Reactor Facility describes over arching responsibilities, procedures and detailed work instructions on how radioactive waste is managed and transferred. The QMS includes requirements for periodic review of procedures on handling, transport, treatment and storage of radioactive waste. It also identifies the process of records maintenance for inspection and environmental monitoring of stored radioactive waste. These are consistent with arrangements currently in place for WOTD.

5.2 Waste Minimisation - Design Systems and Processes

The likely amount and type of waste generated as a result of the operation of the Reactor Facility has been estimated in order to ensure appropriate selection of materials and methods of control. Technical and administrative controls are in place that will reduce the volume and activity of the waste generated during the commissioning and subsequent operation of the Reactor Facility.

In line with the implementation of ANSTO's Radioactive Waste Management Policy, comprehensive measures are in place for the minimisation of waste generation at all of ANSTO's licensed facilities.

These include the minimisation of waste generation at the source by the implementation of systems that incorporate:

1. Segregation of wastes
2. Waste classification and characterisation
3. Delay and decay
4. Recycle and reuse
5. Exempt level waste system
6. Improved decontamination facilities
7. Waste management optimisation – pre-treatment, treatment, conditioning, transportation, storage and disposal
8. Ongoing education and training of operating staff

The Reactor Facility design incorporates various processes that minimise waste generation and include:

- Recycling of water
- Delay and decay of radioactive wastes
- Condensation of water produced by the Hot Water Layer and re-use within the Reactor
- Appropriate material selection.

5.3 Waste Minimisation - Environmental Management System

ANSTO's certified Environmental Management System (EMS) provides the commitment to minimise ANSTO's environmental "footprint". The EMS is compliant with ISO 14001 and provides a structured approach to the identification of environmental aspects and the controls that limit the environmental impacts. Within the EMS there are defined objectives and targets that focus on effective management of airborne, liquid and solid wastes.

5.4 COMPLIANCE WITH APPROPRIATE CODES

There are a number of Codes of Practice relevant to waste management that have been utilised by ANSTO as part of its current arrangements and applicable to the Reactor Facility. These include;

- Code of Practice for the Disposal of Radioactive Waste by the User (1985)
- Code of Practice for the Near Surface Disposal of Radioactive Waste in Australia (1992), and
- Code of Practice for the Safe Transport of Radioactive Material (2001)

In addition, a Trade Waste Agreement is in place between ANSTO and Sydney Water for discharges of trade waste effluent to the sewer. WOTD is responsible for reporting on, and maintaining compliance with, the Trade Waste Agreement. ARPANSA is responsible for monitoring compliance with the Trade Waste Agreement.

5.5 MONITORING, CONTROL, SEGREGATION AND CLASSIFICATION OF RADIOACTIVE WASTE

Arrangements are in place that provide for the monitoring, control, segregation and classification of solid and liquid wastes and airborne emissions. These systems include on-line gamma detection for liquid waste and state of the art air monitoring systems for gaseous stack discharges including online particulate, iodine, noble gas and tritium monitors.

Relevant procedures and instructions to account for sampling, management (including inventory control and waste tracking), waste segregation and classification, prior to transfer of solid and liquid waste to WOTD are covered by the Reactor Facility QMS.

5.6 LIMITING EXPOSURE TO RADIOACTIVE WASTE

The arrangements for minimising exposures to ionising radiation arising from radioactive waste are addressed as part of the Radiation Protection Plan. However, there are some specific features relating to the design and operation of the Reactor Facility that contribute to the minimisation of exposures to ionising radiation from radioactive waste. These are described further in the relevant sections including the management of the solid, liquid and gaseous waste streams.

All credible exposure pathways for radioactive wastes are identified in ANSTO EMAP/TN/-01/2002 Pathways Analysis.

5.7 PACKAGING AND CONTAINMENT OF RADIOACTIVE WASTE

The Reactor Facility is designed with systems that provide for collection, analysis, storage and packaging of solid and liquid wastes prior to transfer to WOTD. Management of the radioactive waste within the Reactor Facility conforms to current best practice, including relevant codes, and is designed to control the potential for spread of contamination and to limit the external dose rates to ALARA levels.

Relevant packaging and containment procedures for the Reactor facility are consistent with established WOTD procedures.

5.8 INTERIM STORAGE OF RADIOACTIVE WASTE

The Reactor Facility has designated interim and longer term storage areas for radioactive liquid and solid waste. The interim storage areas within the Reactor Facility are appropriately located to allow ease of access for both placement and removal of waste, as part of transfer to WOTD.

These storage areas are detailed in the following sections describing the management of the solid and liquid waste streams.

A licensed infrastructure is in place at ANSTO for the interim storage of radioactive wastes including low and intermediate level solid and liquid wastes. The interim storage facilities have adequate capacity to handle the waste arising from the Reactor Facility

5.9 TRANSPORTATION OF WASTE

The transportation of waste from the Reactor Facility is in accordance with the currently licensed arrangements existing at the LHSTC site. All solid waste leaving the controlled areas of the Reactor Facility receives health physics clearance and is moved in accordance with the same systems currently employed by WOTD.

5.10 RECORD KEEPING

Records are kept of all relevant aspects of the generation, control and storage of radioactive waste.

Documentation is produced as an integral part of processes for packaging and containment of radioactive waste. That information provides the appropriate technical details and origin of the various wastes. This is relevant for determining the appropriate storage and treatment strategy for the wastes following their transfer to WOTD.

Similarly, all intermediate level waste is also be tracked. The intermediate level solid waste is collected by WOTD using the 72 litre container shielded retrievable flask and transported to the WOTD dry store.

Low level liquid waste is tracked at the relevant source of generation.

Online waste stream monitors (WASMO) are installed in the two RLWM Storage Tanks. The WASMO monitors the gamma activity providing early warning detection and assisting in the immediate identification of the source. All WASMO online data is kept within the computer database control system for immediate and historical data reference.

The database allows a record of the inventory of liquid waste transferred to ANSTO's WOTD Effluent Treatment Plant to be kept as well as providing relevant information such as the total activity discharged during any time period.

5.11 REPORTING OF RELEASES FROM REACTOR FACILITY

Transfers of solid and liquid waste from the Reactor Facility, together with airborne emissions, are reported as part of the Reactor Facility QMS. This includes quarterly and annual reporting to ARPANSA. In addition to routine reporting, any inadvertent generation of waste, is reported if it gives rise to a release that exceeds notification levels.

5.12 TRAINING OF PERSONNEL

In accordance with the current ANSTO Safety Management System, training is given to personnel involved with radioactive wastes to ensure they understand and comply with the Reactor Facility procedures in place for the handling, treatment, transport, storage, and transfer or ultimate disposal of all radioactive waste. Safety Directives 5.1, 5.6 and 5.7 apply.

6 SOLID WASTE

6.1 SOLID WASTE CHARACTERISTICS

Operation of the Reactor Facility results in the generation of solid waste. In line with IAEA guidelines, solid wastes are classified as low level solid waste (LLSW) or intermediate level solid waste (ILSW). The types and annual amounts of solid waste estimated to be produced are provided in Chapter 12 of the SAR.

Other miscellaneous solid wastes will be generated from time to time. Of these, the most significant are used neutron beam guide tubes and spent cold neutron sources.

Spent Fuel Assemblies are not considered to be solid waste and are treated separately as described in Section 9.

6.2 REACTOR FACILITY SOLID WASTE MANAGEMENT SYSTEM DESCRIPTION

This section details the measures that are in place to control and manage the solid waste streams arising from operation of the Reactor Facility. The measures are fully consistent with those for which ANSTO is currently licensed.

In accordance with ANSTO's operating strategy, solid waste is segregated at the point of generation and waste minimisation principles applied wherever practicable.

Segregation at source produces three streams of solid wastes: Inactive or exempt-level, LLSW, and ILSW.

Inactive wastes are disposed of directly through the municipal waste management system. Exempt level wastes are processed through the existing ANSTO exempt level waste clearance system.

LLSW are classified in accordance with the ANSTO classification system. Radioactive solid waste packages are managed in accordance with existing procedures.

ILSW is stored in the service pool where a shearing facility is available to cut large items into smaller sizes for more efficient storage. Long lived intermediate level solids are transferred to storage in a shielded container.

6.3 DESIGN FEATURES OF STORAGE FACILITIES

The Reactor Facility is designed to accommodate the handling of waste generated as part of its operations and to minimise exposure to ionising radiation as a result of handling this waste.

6.3.1 Service Pool

The Service Pool provides adequate space for the storage of spent Fuel Assemblies, damaged rigs and used rigs undergoing decay. It also contains facilities for cutting and size reduction of waste items together with sufficient room to store the 72 litre aluminium container used for the removal of solid waste from the Service Pool.

Short-lived ILSW is left to decay until it can be re-classified and processed as LLSW. Long-lived ILSW is transferred to WOTD in a shielded container for interim storage pending final disposal.

6.3.2 Interim Storage Areas

The Reactor Facility has a number of dry waste storage rooms. The primary purpose of one of these rooms is for the interim storage of the HEPA and charcoal filters collected from the

Reactor Facility ventilation systems. By storing ventilation filters in this low occupancy room, delay and decay assists the reduction of dose to staff.

Another additional interim waste storage facility is available for waste that is ready for transfer from the Reactor Facility.

6.3.3 Spent Resin Storage Facility

Ion-exchange resins are used as part of the purification systems for the light water of the Reactor and Service Pools and the hot water layer. They are also used for the purification of the heavy water contained in the Reflector Vessel. Resin handling areas exist for both the light and heavy water systems. Each of the resin beds is properly located in a segregated and shielded room that provides adequate shielding to staff during normal operations.

Once resins from the light water system are spent they are remotely transferred to spent resin storage tanks, located within the Resin room, to allow delay and decay for approximately 12 months prior to removal from the Reactor Facility to WOTD.

6.3.4 Pile Assemblies Storage Room

Approximately every 10 years, four in-pile neutron guide assemblies will be replaced. The used neutron guide assemblies will be stored in the Pile Assemblies Storage Room. The room has a number of positions available for storage of the depleted neutron beam guides, the in-pile assemblies, the 3 primary shutter cassettes and other irradiated components.

6.4 MANAGEMENT OF SOLID WASTE COMPONENTS

6.4.1 Irradiated Target Cans

Cans composed of three different materials are irradiated in the reactor: high purity aluminium, high-density polythene and titanium. The titanium cans are 100% recyclable. Polythene cans are not reusable and are treated as LLSW. Aluminium cans are reusable for a limited number of times, requiring decontamination prior to reuse.

6.4.2 Used or Damaged Irradiation Rigs or Components

There are 18 irradiation rigs made of Al 6061. These are replaced every four years, at which time the respective thermocouples are also replaced. They are disassembled under water and then transferred to the Service Pool. The discharged thermocouples are also stored in the Service Pool until removed.

6.4.3 Neutron Beams Guides

Neutron beam guides are replaced approximately every ten years and treated as ILSW.

6.4.4 Cold Neutron Source

Approximately every 10 years a Cold Neutron Source will be replaced. The Cold Neutron Source is constructed of aluminium and stainless steel. As the aluminium is prone to degradation by radiation, the in-pile assembly will be replaced. The waste aluminium will be transferred to the Service Pool to decay after which it will be cut to separate it from the stainless steel and to a size small enough to fit into the retrievable container.

6.4.5 Spent Control Rods

The 5 Control Rods used to control the nuclear reaction in the core will be replaced every 10 to 12 years. They will be stored in the Reactor Pool until their activity has decayed sufficiently.

They will be then removed, cut up in the Service Pool, and placed in retrievable containers and transferred to storage.

6.5 LIMITING EXPOSURE TO SOLID WASTE

Dose is minimised in a number of ways including:

- Design and location of storage facilities (shielding and occupancy).
- Delay and decay process for products in the Service Pool, and other dedicated storage facilities as described above.
- Radiation and contamination monitoring of waste items to ensure appropriate storage and segregation of waste items, and
- Appropriate shielding of transport containers.

6.6 MONITORING AND CHARACTERISATION OF SOLID WASTE

The solid wastes are packaged and stored in accordance with established ANSTO procedures. The waste packages are characterised on the basis of the contact dose, the specific activity (where possible), process knowledge, and the type of waste. In addition to radiological properties, essential physical, chemical and mechanical properties are defined. Generally, classification of solid wastes is performed by using hand held monitors to determine the dose rates and the level of external contamination that may be present.

6.7 REMOVAL OF SOLID WASTE FROM REACTOR FACILITY

Solid waste being prepared to leave the Reactor Facility is subject to the existing control measures in place at ANSTO. All solid waste is monitored for radiation and contamination to ensure that it is within licensed limits. Appropriate documentation of solid waste clearances from the facility is provided in accordance with currently agreed procedures.

7 LIQUID WASTE

Liquid discharges from the Reactor Facility to the “B” or “C” lines will comply with the limits specified in Safety Directive 5.7. All of the above liquid wastes will be processed and discharged to the sewer. Discharge to the sewer will be in accordance with Trade Waste Agreement limits set with Sydney Water and monitored by ARPANSA.

7.1 LIQUID WASTE CHARACTERISTICS

Radioactive liquid waste generated by operations of the Reactor Facility comprises of low level liquid waste as defined in ANSTO SD 5.7.

As described below, liquid waste arising from operations of the Reactor Facility is directed to either B or C lines on the LHSTC site.

7.2 REACTOR FACILITY LIQUID WASTE MANAGEMENT SYSTEM DESCRIPTION

Arrangements are in place within the Reactor Facility for the monitoring, sampling, control, segregation and classification of radioactive and non-radioactive liquid waste originating as a result of the operation of the facility. All liquid wastes are transferred from the Reactor Facility to the ANSTO Liquid Waste Treatment Plant.

The Reactor Facility has systems that monitor and record all active or potentially active effluents exiting the Reactor Building. The liquid waste from both “C” and “B” Lines is temporarily stored in Radioactive Liquid Waste Management System (RLWMS) storage tanks, one for each line.

The capacity of the tanks allow for buffer storage, delay and decay of short-lived radionuclides prior to discharge to the effluent system.

Both RLWMS storage tanks are interconnected and are provided with a set of valves that allows for transferring the contents between the tanks. If either of the storage tanks is out of service, the operation can be temporarily taken over by the other (receiving the liquid waste from both lines).

Both RLWM storage tanks have a Waste Streams Monitoring (WASMO) online gamma activity detector for the inlet streams that records both the time and the activity.

"Spent" heavy water (isotopically beyond specification) is removed and stored in appropriate containers. The heavy water transfer system is designed to prevent losses.

From a waste management standpoint, no significant amounts of heavy water waste, either in liquid or vapour form, are generated by the operation of the Reactor Facility.

7.2.1 Liquid Waste Storage Facilities

The Reactor Facility will generate three types of liquid waste:

- Non-active blowdown water – dedicated blowdown line
- Normally non-active liquid waste, and
- Low level liquid waste

7.2.1.1 Non-active blowdown water

The Cooling Water Blowdown does not discharge into RLWMS "C" Line Storage Tank but is pumped periodically to WOTD's Liquid Waste Treatment Plant Holding Tanks via a dedicated new blowdown line.

7.2.1.2 Normally Non-Radioactive Liquid Waste ("C" Line)

While most liquid waste going to the "C" line storage tank is inactive, for assurance, it is assumed to potentially contain activity until analysed.

7.2.1.3 Low-level Radioactive Liquid Waste ("B" Line)

This line collects liquids with an activity above the one collected in "C" Line and with activity below or equal to the "B" Line limit.

Liquid waste intended for discharge to the "B" line from laboratories or controlled areas within the Reactor Facility is first discharged to a portable receiver by means of a drain valve arrangement at the source. The liquid is kept within the receiver until a sample is analysed. If the sample falls within the permissible limit, the liquid is discharged to the "B" line and thence to the RLWMS "B" Line Storage Tank by gravity. If the sample falls outside the permissible limit, the liquid is transferred to a movable shielded tank by means of a portable pump. The shielded tank is removed and collected by WOTD for further processing.

7.3 LIMITING EXPOSURE TO LIQUID WASTE

Limiting exposure to the ionising radiation associated with the liquid waste in the Reactor Facility has been taken into account in the design of the facility.

The two liquid waste storage tanks are located in a very low occupancy area. This minimises the potential exposures to staff by ensuring that the waste is not in an area that staff frequent as part of routine operations.

7.4 MONITORING AND CHARACTERISATION OF LIQUID WASTE

Liquid wastes transferring to the RLWMS Storage Tanks are monitored by the Waste Streams Monitor (WASMO) as part of the determination of their activity. Discharge from the RLWMS Storage Tanks is monitored by the Liquid Effluent Monitor (LEM) as part of transfer procedures. (this remote monitoring also assists with the minimisation of operator doses as discussed above).

Liquid waste from the de-mineralised Water Plant discharges to the "C" Line..

All low level liquid wastes generated within the Reactor Facility will be monitored either by online gamma monitors or analysed prior to discharge. The maximum discharge levels for gross alpha, gross beta and tritium are established in ANSTO SD 5.7.

8 GASEOUS WASTE

Details of gaseous waste are described in Chapter 12 of the SAR and the Environment Management Plan.

Airborne emissions may be derived from different sources including:

a) Gaseous radioactive elements or compounds from the pools, coolant systems, Heavy Water Room and experimental facilities.

b) Airborne radioactive elements from areas such as laboratories.

Included in the consideration of gaseous waste are the fine airborne particulates that may also be radioactive. These are removed from relevant streams by HEPA and charcoal filtration prior to discharge via the stack.

8.1 REACTOR FACILITY GASEOUS WASTE MANAGEMENT SYSTEM DESCRIPTION

The Reactor Facility has been divided into several zones according to the potential for contaminated air hazards. Those rooms with potential for gaseous waste generation have provisions for air renewal and for purification through appropriate filters. The air flow is directed from areas of low contamination risk to areas of higher contamination risk.

In rooms where personnel access is not necessary during operation, the air is confined or the rooms submitted to independent localised treatment (e.g. the Heavy Water Room).

The ventilation system for controlled areas outside the Containment has in-line HEPA filters and charcoal bed absorbers and discharges via the stack.

Radioactive gases may be produced in areas within the Containment. The ventilation system removes air from the Reactor Hall and process rooms. The exhaust fans pull the air through HEPA filters to remove small particles with high efficiency.

Area radiation monitors monitor gamma activity at representative points in the Reactor Facility. A tritium monitoring system constantly measures tritium concentration in the Heavy Water Room. The system is complemented by portable equipment in the event of maintenance activities being performed in the area.

The pneumatic target cooling and triggering system is a closed system that uses nitrogen both for pneumatic transport and for target cooling. Target loading and unloading devices also have nitrogen sweeping to reduce air entry to the system.

The Argon-41 produced in the Reactor Pool will be primarily that arising from the activation of the argon dissolved in the water circulating through the core. The air effluent monitoring system will have high-activity alarms and will constantly register the activity emitted.

For the Reflector Cooling and Purification System (RCPS), as well as for the tritium-handling glove box facilities, the equipment and expected operating conditions are consistent with the application of the ALARA principle, allowing emissions to be kept to a minimum.

During reactor operation, the Reflector Vessel is kept at a pressure such that any leak will lead to the entry of light water into the RCPS.

The RCPS is cooled via an intermediate circuit, allowing detection of any potential release to the atmosphere via the Secondary Cooling System.

The deuterium generated through radiolysis is passed through a catalytic re-combiner unit, turning the deuterium gas into heavy water which is then returned to the system.

8.2 Limiting Exposure to Gaseous Waste

The likely potential pathways of exposure to staff from gaseous waste generated from the operation of the Reactor Facility are:

- Exposure to Ar-41 and to the external radiation fields generated by the collection of particulate and gaseous radioactive materials on the HEPA and activated charcoal filters that form part of the Reactor Facility ventilation system;
- Inhalation of airborne radioactive materials present in the workplace; and
- Ingestion of radioactive materials in particulate form in the workplace.

The hot water layer reduces internal and external exposure to staff both from to radionuclides present in the water.

Exposures to external radiation fields generated by the collection of particulate and gaseous radioactive materials on the HEPA and activated charcoal filters have been minimised by building dedicated filter rooms that segregate these items from other plant items. This means that staff in other areas of the plant will receive less exposure than if the filters were located in the main plant rooms.

8.3 Monitoring and Characterisation of Airborne Discharges

Gaseous and particulate discharges from the Reactor Facility via the stack are monitored. Detectors are in place to reliably measure and record the releases of tritium, radioactive gases, radioactive iodine and radioactive aerosols.

A fixed tritium monitoring unit continuously samples air coming from the Heavy Water Room.

A portable Tritium in Air monitoring unit is also available to sample air in areas where tritiated water may be present as part of routine analysis.

9 FISSILE MATERIALS

Fissile material will be present in the spent Fuel Assemblies which are described in the plans and arrangements document dealing with ultimate disposal and transfer.

Spent Fuel Assemblies discharged from the reactor core are moved a short distance under water into storage racks in the Service Pool. These racks have the capacity to safely store, under water, up to 10 years' arisings of spent fuel discharged from the reactor, while retaining sufficient spare space to unload the complete operating reactor core at any time should this be required. The racks in which the spent Fuel Assemblies will be stored have been designed to preclude the possibility for inadvertent criticality. This arrangement has the advantages of minimising handling of the spent Fuel Assemblies. The spent Fuel Assemblies will also be protected by the same structural features as the reactor itself.